THE AMERICAN MINERALOGIST
JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

Vol. 17 DECEMBER, 1932 No. 12

A NEW OCCURRENCE AND X-RAY STUDY OF MOSESITE

PAUL H. BIRD, *Columbia University.*

INTRODUCTION

Mosesite from Terlingua, Texas was originally described by Canfield, Hillebrand and Schaller.[1] The mineral was found in association with eglestonite, terlinguaite, montroydite and kleinite in the quicksilver mining district. Soon after the original description appeared, Schaller[2] made a more thorough and extended study of the mineral. Since that time, however, search of the literature indicates the absence of any record of the occurrence of mosesite at any other locality. Recent studies, however, have demonstrated the presence of the mineral in association with the mercury minerals of the T. S. Clack Quicksilver Mine in the Fitting District, Nevada. It appears that a description of the new occurrence of this rare mineral is worthy of record. In addition to the description of a new locality for mosesite the study has provided *x*-ray data which may be used in distinguishing mosesite from the minerals with which it has been found to occur.

Dr. Paul F. Kerr, of Columbia University, in company with Mr. C. D. Woodhouse, general manager of Champion Sillimanite Co., collected the specimens upon which this study is based during the summer of 1931. Dr. Kerr has also offered suggestions and has assisted in taking *x*-ray photographs. Dr. A. F. Rogers, of Stanford University, has kindly read the manuscript and offered valuable suggestions. Mr. A. M. Smoot, of Ledoux and Co., has generously assisted the investigation through his painstaking procedure and personal attention he has given to the chemical analysis.

LOCATION AND OCCURRENCE

The Clack Quicksilver Mine where the specimens of mosesite were found is situated on the eastern side of the mountainous terrane between Star Range and Buffalo Mountain in Pershing County, Nevada, about twenty-three miles northeast of the town of Lovelock. The elevation above sea level is approximately 5500 feet.

---

[1] Canfield F. A., Hillebrand, W. F., and Schaller, W. T., Mosesite, a New Mercury Mineral from Terlingua, Texas: *Am. Jour. Sc.*, 4th. Ser., vol. **30**, pp. 202–208, 1910.

[2] Schaller, W. T., *Bull.* **509** *U.S.G.S.*, pp. 104–109, 1912.

The discovery upon which the present quicksilver mining operations are based was made in 1927. A small amount of high grade ore, however, had been previously taken from a prospect shaft. The chief ore mineral is cinnabar, and the average ore carries between 2 per cent and 3 per cent of mercury. The mine is located on a hillside, and may be entered either from an untimbered shaft extending downward 350 feet from the surface, or from the haulage tunnel on the 350-foot level. It is estimated that between 1000 and 1500 flasks of mercury have been extracted since the mine was opened.

The country rock is a fine-grained, massive, medium-gray limestone, probably Tertiary in age. No evidence of fossiliferous remains were observed in the specimens studied, but it has been reported that a few fossils have been found in the vicinity.

A microscopic study of thin sections shows that the rock has been subjected to intense deformation. Places may be observed where evidence of four distinct periods of fracturing appear within one field of view. The fracturing has been so severe and thorough that it is difficult to find a field of view that does not show several fractures. The rock is essentially a pure limestone with a very minor amount of quartz. The latter occurs in two distinct forms. An occasional grain may be observed that is well rounded, and has apparently had no connection with the fracturing and mineralization of the rock. These are interpreted as original fragmental grains deposited with the limestone. In addition, patches and streaks of very small, euhedral quartz crystals are sparsely distributed throughout the rock. An interesting but minor feature is the occurrence in these crystals of minute, detached particles of calcite distributed in planes parallel to the crystal faces. It appears that the quartz forming these crystals was introduced by solutions contemporaneously with the fracturing and healing of the rock.

The cinnabar together with crystalline calcite occurs as a replacement in veins and in small irregular masses in the limestone. The gangue is probably more than 95 per cent calcite, the latter occurring as a microscopically coarse crystalline mass. The only other gangue mineral is quartz. In occasional instances areas may be observed in which the quartz exhibits the comb structure of vein quartz. Several small areas were noted which suggest that part of the quartz is genetically related to the cinnabar.

Native mercury occurs in small openings in the limestone. Specimens of the unusual mercury mineral mosesite occur along with native mercury. The latter, however, is found only in a few places near the surface and in small concentrations.

MOSESITE

OCCURRENCE. In the original description of mosesite from Terlingua, Canfield[3] comments upon the mineral as occurring in small yellow crystals perched upon crystals of calcite. He states that the crystals occur isolated and solitary, and appear to lie upon the calcite with little or no bond as if the slightest touch would loosen them, leaving no scar upon the calcite but merely a clean spot.

The description of the occurrence of mosesite at Terlingua agrees in general with the description of the occurrence of this mineral as it is found in the Fitting District. In Nevada, however, the crystals occur chiefly in small groups of two or three, the individuals of which are intergrown in a very irregular manner.

GENERAL DESCRIPTION. No attempt has been made to measure the interfacial angles by means of the goniometer on account of the small size of the crystals available, and their apparent irregularities. Schaller[4] experienced considerable difficulty in obtaining accurate measurements of the crystals from Terlingua, and similar difficulties seem inescapable in the case of the specimens from the Fitting District. Study under a binocular microscope and with a hand lens indicates that the crystals from the latter place are chiefly octahedra, in some cases slightly modified by small dodecahedral faces. A few crystals with a predominant cubic habit have been observed. Schaller[5] noted the probable occurrence of twinning according to the spinel law in the Terlingua material, and the same appears to apply to that from the Fitting District.

The color of the crystals studied is a pale canary yellow when taken from the mine. This color will change to a light olive green after two months' exposure in ordinary room light. This observation differs from that of Canfield,[6] who stated in his original description of the mineral that there were no indications that the crystals were affected by light. He did admit, however, that "If the light affects the color, it must act very slowly." One of the best specimens in the mineral suite from the Fitting District was left exposed to ordinary room light, but protected from the direct rays of the sun, and observed every few days and compared with a specimen that was kept in the dark. The change in color was not noticeable for at least a month, and even then progressed very slowly.

---

[3] Canfield, Hillebrand, and Schaller, *op. cit.*

[4] Schaller, W. T., *op. cit.*

[5] Schaller, W. T., *op. cit.*

Mosesite from either Texas or Nevada does not appear to change color on grinding. The closely related mineral eglestonite from Terlingua, Texas, turns dark gray when finely powdered.[7]

Several of the crystals were crushed and mounted in Canada balsam for microscopic study. Apparently the optical properties agree with those given by Schaller. The crystals are pale yellow in color, and show no pleochroism. They exhibit at least a strong suggestion of octahedral cleavage, and possess a rather uneven birefringence in polarized light. Schaller found that when heated above 186 degrees centigrade the mineral becomes isotropic, and therefore corresponds optically with the observed crystal form only at this higher temperature.

The observed hardness, luster, streak, and brittleness appear to agree with the recorded observations of Canfield, Hillebrand, and Schaller.[8]

Chemical Analysis. A small sample, weighing only 5.88 milligrams, was submitted to Mr. A. M. Smoot of Ledoux and Company, New York City. Mr. Smoot very kindly performed all the work personally, realizing the difficulties that were to be expected in working with such a small amount of material. His results are given in Table 1. In commenting on the accuracy of this analysis, he says: "The mercury determination may be three or four per cent out of the way; the chlorine may be one per cent out, one way or the other. The SO_4 determination and the NH_3 determination I believe are fairly close, considering the small amount of sample available." The chief discrepancy between these results and those of Hillebrand,[9] it will be noted, is in the SO_4 content. Hillebrand's analysis showed $3\frac{1}{2}$ per cent of SO_4; just half that shown in Mr. Smoot's analysis. However, Hillebrand states that his values are no more than approximations, which coupled with the difficulties encountered by Mr. Smoot, indicates that too much stress should not be placed on the quantitative results obtained. The real significance attached to the results of Mr. Smoot lies in the fact that he established the presence of mercurous mercury in the mineral, presumably with mercury bound to chlorine. In this connection Hillebrand states: "It will be remembered that the chemical evidence points to kleinite being a mixture of mercury-ammonium chloride with a mercuric sulphate and perhaps chloride. There would seem to be an association of a similar character in mosesite, but with a mercurous sulphate or chloride replacing in part or wholly the corresponding mercuric salts of kleinite." This difference he accepts as a certain means of distinguishing mosesite from kleinite. Since the mercurous form of mercury was definitely proved to be present, and since the other elements correspond qualitatively, and as closely as could be expected quantitatively with those found in mosesite as originally described, it is concluded on chemical grounds that the mineral from the Fitting District is mosesite.

---

[6] Canfield, Hillebrand, and Schaller, *op. cit.*

[7] Eglestonite from Redwood City, California, retains the light color when finely powdered.

[8] Canfield, Hillebrand, and Schaller, *op. cit.*

TABLE 1

CHEMICAL ANALYSIS OF MOSESITE FROM THE FITTING DISTRICT, NEVADA*

Mercury (Hg)	83.00%+
Chlorine (Cl)	5.00%±
Sulphuric acid (SO_4)	7.00%
Ammonia (NH_3)	2.20%

* By Mr. A. M. Smoot of Ledoux and Co., New York City

X-RAY ANALYSIS. A preliminary examination of the material from Nevada led to the opinion that the small yellow crystals might be eglestonite. Accordingly several *x*-ray diffraction patterns of the material were compared with *x*-ray diffraction patterns of eglestonite from the Egleston Collection of Columbia University. This comparison showed conclusively that the mineral from Nevada was not eglestonite. This preliminary investigation indicated that 15 milligram samples were close to the optimum amount for the production of clear, distinct patterns.

---

[9] Canfield, Hillebrand, and Schaller, *op. cit.*

Specimens of kleinite, terlinguaite, montroydite, and mosesite from the Texas locality were then prepared for x-ray examination, and diffraction patterns made of each. The results were very gratifying, and furnished what is considered the most reliable data of any of the methods of determination attempted. The pattern of mosesite from Terlingua and that of the mineral from the Fitting District were identical with the exception of the intensity of one line, which was a trifle fainter in the one from the latter locality. Figure 1 is a reproduction of the two patterns side by side.

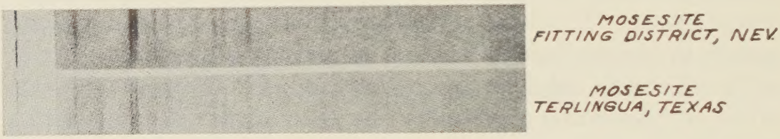


Fig. 1. Reproduction of diffraction patterns of mosesite from the Fitting District and from Terlingua.

The Miller indices of the atomic planes represented in the patterns of eglestonite and mosesite were determined by means of the Cubic Crystal Analyser.[10] Mosesite appears by this means of analysis to have a unit cell with a diamond type of space lattice, while eglestonite has a unit cell with atoms arranged according to the simple cube space lattice. The unit cube of mosesite measures approximately 9.55 Angstrom units on a side, and that of eglestonite approximately 9.50 Angstrom units. The computations of the interplanar spacings were checked with the values determined by calculation based on the theoretical ratios of the various interplanar spacings to each other.

It was found in determining the Miller indices of the atomic planes represented that there was one line in the eglestonite and one in the mosesite pattern that did not correspond to any possible plane that could exist in harmony with the isometric symmetry. It was this particular line that appeared a little more intense in the pattern of mosesite from Terlingua than in that from the Fitting District, as already stated. Upon further investigation it was found that a line appeared in about the same position in the patterns of all the other minerals of this group, but with much greater intensity in the pattern of montroydite, in which it was the most

---

[10] Made by Adam Hilger, London, England.

TABLE 2

X-RAY DIFFRACTION MEASUREMENTS OF MOSESITE

Estimated intensity	Calculated interplanar spacing in A.U.	Theoretical interplanar spacings in A.U.	Miller indices of forms
8	5.510	5.510	(111)
10	2.874	2.875	(311)
10	2.757	2.755	(111) $n=2$
6	2.388	2.388	(100)
6	2.201	2.189	(331)
4	1.844	1.836	(111) $n=3$ (511)
6	1.687	1.687	(110) $n=2$
6	1.621	1.614	(531)
1	1.496	1.509	(310)
8	1.438	1.439	(311) $n=3$
2	1.376	1.377	(111) $n=4$
4	1.331	1.337	(711) (551)
5	1.242	1.242	(553) (731)
4	1.084		
1	1.064		
1	1.038		
2	.950		
2	.913		
1	.825		
1	.799		

TABLE 3

X-RAY DIFFRACTION MEASUREMENTS OF EGLESTONITE

Estimated intensity	Calculated interplanar spacings in A.U.	Theoretical interplanar spacings in A.U.	Miller indices of forms
10	3.163	3.164	(221) (100) $n=3$
1	2.739	2.740	(111) $n=2$
7	2.538	2.538	(321)
1	2.233	2.240	(411) (110) $n=3$
4	2.070	2.071	(421)
7	1.948	1.938	(211) $n=2$

Table 3 (*Continued*)

Estimated intensity	Calculated interplanar spacings in A.U.	Theoretical interplanar spacings in A.U.	Miller indices of forms
7	1.894	1.900	(430) (100) $n=5$
1	1.684	1.678	(110) $n=4$
1	1.587	1.586	(100) $n=6$ (221) $n=2$
2	1.452	1.449	(533)
1	1.367	1.370	(111) $n=3$
1	1.216	1.207	(732) (651)
1	1.170	1.161	(733)
1	1.083		

Table 4

X-Ray Diffraction Measurements of Kleinite, Terlinguaite and Montroydite

Kleinite		Terlinguaite		Montroydite	
Estimated intensity	Calculated interplanar spacings in A.U.	Estimated intensity	Calculated interplanar spacings in A.U.	Estimated intensity	Calculated interplanar spacings in A.U.
2	5.228	4	5.877	3	5.262
6	3.884 (?)	4	4.182	10	3.848
10	2.914	4	3.884 (?)	5	2.864
10	2.615	10	3.263	1	2.617
1	2.504	6	2.814	3	2.402
6	2.013	2	2.633	3	1.762
2	1.836	10	2.506	3	1.497
2	1.762	2	2.204	1	1.441
2	1.694	2	2.091	1	1.180
2	1.614	4	1.966	1	1.141
2	1.568	1	1.838	1	1.132
2	1.503	6	1.762	1	1.013
4	1.434	2	1.590		
4	1.242	2	1.492		
1	1.135	1	1.258		
1	1.077	0.5	1.164		
1	.945	0.5	1.133		
0.5	.825	0.5	1.090		

intense line. This fact would appear to indicate the presence of a trace of montroydite in the other minerals of the group. This line is not shown in the tables or chart for eglestonite and mosesite.

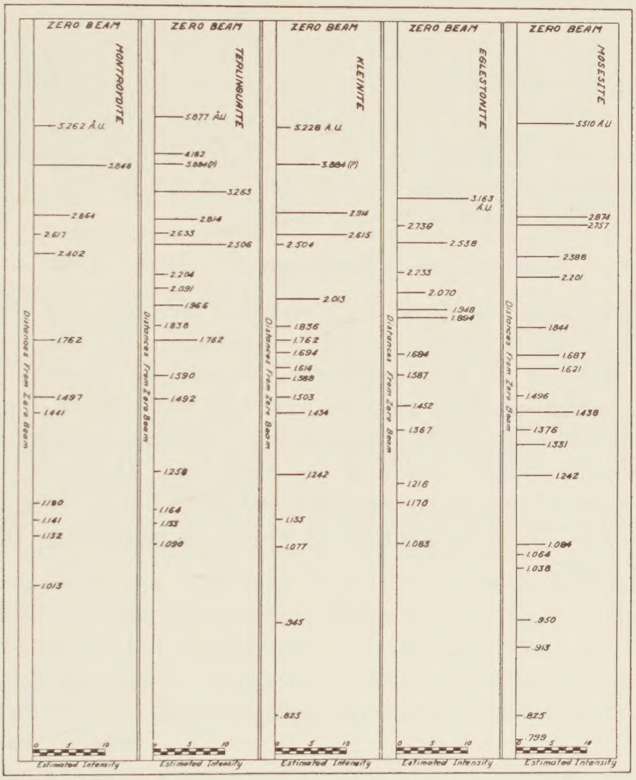


FIG. 2. Graphic representation of x-ray data obtained from a study of the rare mercury minerals first described from Terlingua, Texas. The distances from the zero beam represent the measured arc; the length of the vertical lines the estimated intensity, and the values given are the calculated interplanar spacings.

The results of the x-ray work on all five of these rare minerals are given in Tables 2, 3, and 4. Table 2 gives the estimated intensity, calculated and theoretical interplanar spacings, and Miller indices of the planes represented for mosesite. Table 3 shows the same for eglestonite. Table 4 shows the estimated intensity and interplanar spacings for terlinguaite, montroydite, and kleinite. The calculation of each interplanar spacing for all the minerals was checked against sodium chloride and corrected. Figure 2 is a chart presenting the x-ray data in graphical form. The measurement of the arc for each line as taken directly from the diffraction pattern is plotted along the horizontal lines, and a vertical line drawn at each point so determined. The length of each vertical line represents the estimated intensity of the line which it represents in the diffraction pattern as shown by the scale. At the end of each vertical line is given the interplanar spacing calculated for that line and corrected with the known theoretical value of a line occupying approximately the same position in a pattern of sodium chloride taken on the same strip of film.

CONCLUSION

Studies based chiefly on data obtained by x-ray and chemical analyses indicate the occurrence of mosesite in the Clack Quicksilver Mine, in the Fitting District, Nevada. In connection with this investigation x-ray analyses were also made of the other rare mercury minerals, namely: eglestonite, terlinguaite, montroydite and kleinite, which were first described from Terlingua, Texas. Each of these minerals gave a characteristic and distinctive diffraction pattern, the measurements of which are recorded in the preceding pages.

THE LEPIDOLITE SYSTEM

A. N. Winchell, *University of Wisconsin.*

In previous studies[1] of the mica group it was concluded that the lepidolite system belongs to the heptaphyllite micas and differs from the muscovite system in the number of its oxygen atoms. Since the date of those studies, Mauguin[2] has shown by x-ray methods that all micas have very similar crystal structures and that all contain 24 atoms of O+F in their chemical formulas. A table of percentage number of non-oxygen (+H+F) atoms calculated from 26 analyses of lithia micas (selected as probably the most accurate now available) shows that K+Na varies from 12.9 to 14.9 per cent; this was taken to indicate that the formula contained fourteen non-oxygen atoms. It was shown that the best analyses have between 21 and 22 oxygen (+F) atoms for fourteen non-oxygen atoms. With the evidence discovered by Mauguin that the molecule contains 24 oxygen (+F) atoms, it follows that the number of non-oxygen atoms must be sixteen. The lepidolite system must therefore be classed with the octophyllite micas rather than with the heptaphyllite micas.

Another conclusion may be drawn from these data. The lithia micas contain more than two K+Na atoms among each sixteen non-oxygen atoms. This may mean that there is a variation in composition, some component molecules containing more than two K+Na atoms, but an alternative explanation (which seems preferable) is that the Na atoms do not proxy exclusively for K in the lithia micas, since K atoms alone never exceed 12.5 per cent of the non-oxygen atoms.

If the lepidolite system belongs with the octophyllite micas what are the formulas for its component molecules? An attempt to solve this problem has met with little success, but one lithia mica (protolithionite) approaches annite in composition. It is reasonable to suppose that the lithia mica system must contain *some* lithium in all its component molecules, and, assuming a minimum of one atom of Li to 24 oxygen atoms, the formula of protolithionite may be written as $H_4K_2LiFe_4Al_3Si_6O_{24}$. Certain good lepidolite analyses approximate to $H_3K_2Li_3Al_4Si_7O_{24}$, but other good analyses vary considerably from this in their tenor of alumina and silica. The range of good analyses is represented approximately by assuming a variation from $H_4K_2Li_3Al_5Si_6O_{24}$ to $H_2K_2Li_3Al_3Si_8O_{24}$. These formulas are not entirely satisfactory; they require too much lithia for some analyses and they do not require as much OH (and F) as shown by some analyses. The first difficulty can be remedied in part by using $H_2K_2Li_2Al_6Si^6O_{24}$ in place of $H_4K_2Li_3Al_5Si_6O_{24}$, but that increases the second difficulty. With present data the writer is not now able to find a better solution of the problem.

---

[1] A. N. Winchell: *Am. Jour. Sci.*, **IX,** 1925, pp. 309 and 415, and *Am. Mineral.,* **XIII,** 1927, p. 267.

[2] C. Mauguin: *Comp. Rend,* **186,** 1928, pp. 879 and 1131

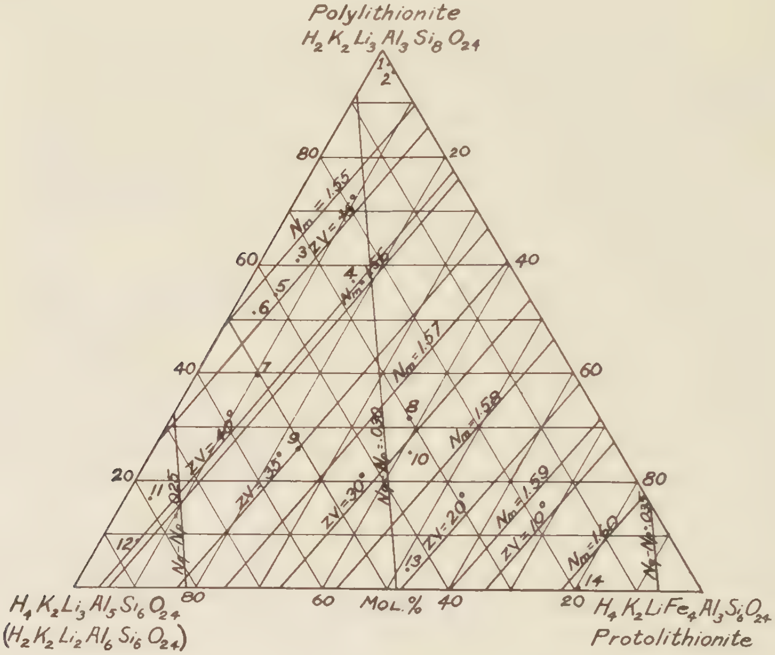


FIG. 1. Variations in composition and optic properties in the lepidolite system.

The relations between variations in composition and variations in optical properties are shown in Fig. 1. In this figure Fe_2O_3 is considered equal to 2FeO; MnO (and even MgO) is computed with FeO. The fluorine, abundant in lithia micas, is considered equal to hydroxyl. Some examples do not agree well with the diagram. In some cases this is probably due to the presence of more Al and less Li than shown in the molecules of the diagram. In other cases a different explanation must be sought. Thus, Simpson's analyzed lepidolites should have an optic angle of about 45°; they are essentially uniaxial. This may be due to fine twinning on (001). Also certain lithia micas are reported to be triclinic, while others (even in the same rock) seem to be monoclinic. Apparently these micas are dimorphous, and that condition would doubtless entail variations in optical properties, the extent and character of which are at present unknown.

References for Figure 1

1. Duparc, Wunder et Sabot: *Mem. Soc. Phys. Hist. Nat. Genève*, **XXXVI**, 1910, p. 367. $N_m=1.5307$, $N_g-N_p=.0314$, $2V=45\frac{1}{2}°$. 2. Duparc, Wunder et Sabot: *op. cit.:* $N_m=1.5522$, $N_g-N_p=.0244$, $2V=45°50'$. 3. W. Kunitz: *N. Jahrb. Min., Bl. Bd.*, **L,** 1924, p. 365. $N_m=1.5525$, $N_g-N_p=.0268$, $2V=46\frac{1}{2}°$. 4. W. Kunitz: *op. cit.* $N_m=1.5626$, $N_g-N_p=.0291$, $2V=40°28'$. 5, 6. E. S. Simpson: *Am. Jour. Sci.*, **IX,** 1925, p. 424. $N_m=1.5550$, $N_g-N_p=.0224$, $2\mathrm{V}=0°$. 7. W. Kunitz: *op. cit.* $N_m=1.5574$, $N_g-N_p=.0288$, $2\mathrm{V}=43°46'$. 8. W. Kunitz: *op. cit.* $N_m=1.5754$, $N_g-N_p=.0307$, $2V=31°16'$. 9. W. T. Schaller: *Am. Jour. Sci.*, **XXIV,** 1907, p. 158. $2E=57° \therefore 2V=35° \pm$. 10. W. Kunitz: *op. cit.* $N_m=1.5777$, $N_g-N_p=.0301$, $2V=29°36'$. 11. J. Sekanina and J. Vyslouzil: *Min. Abst.*, **IV,** 1930, p. 379. $N_m=1.558$, $2E=63° \therefore 2V=39°$. 12. C. H. Stockwell: *Ph.D. Thesis, Univ. Wis.*, **1931.** $N_m=1.570$, $N_g-N_p=.031$, $2V=40°$. 13. W. Kunitz: *op. cit.* $N_m=1.5850$, $N_g-N_p=.0304$, $2V=20°42'$. 14. W. Kunitz: *op. cit.* $N_m=1.6057$, $N_g-N_p=.0333$, $2V=0°$.

QUARTZ-DIOPSIDE-GARNET VEINLETS

G. E. Goodspeed and Howard A. Coombs,
University of Washington.

Recently the attention of the writers has been attracted by certain veinlets apparently related to granodioritic intrusives. Two occurrences are discussed, one near Snoqualmie Pass in the Cascade Range of Washington, and the other near Cornucopia, Oregon, on the south eastern border of the Wallowa mountains. These are so similar in textural characteristics and mineral assemblages that their description in a single paper is warranted even though they are separated in time from late Mesozoic to Miocene and in distance by several hundred miles.

Cascade Occurrence

The reconstruction of the Sunset highway across the Cascades of Washington has afforded several excellent exposures along the contact of the Snoqualmie batholith. Some of the best are on the southeastern side of the highway about one mile west of the summit, half way between Lodge Creek and Rockdale Creek. This locality is approximately 65 miles east of Seattle.

Here the contact is irregular and probably represents the top of a stock-like mass. The invaded rock is the Guye formation, which locally is a fine grained quartz biotite schist containing 50 per cent quartz, 40 per cent biotite, 8 per cent oligoclase with minor amounts of magnetite and apatite. Smith and Calkins give the following summary of this formation;

> The age of the Guye is probably Miocene. However, nowhere is the base nor the top exposed and the known extent of the formation is limited to the northwest corner of the Snoqualmie quadrangle. The formation is composed of detrital rocks with some chert and limestone and interbedded basalts. Clearly intrusive into the Guye is the Snoqualmie granodiorite with its age established as late Miocene or post Miocene. Subsequent erosion has furnished excellent exposures of the intrusive contact.[1]

At this locality the granodiorite is light gray in color, coarsely granular in texture and is composed of approximately 55 per cent plagioclase, 25 per cent quartz, 10 per cent biotite, 7 per cent orthoclase with minor amounts of magnetite, apatite, zircon and titanite. Plagioclase is zonal with cores approaching an intermediate oligoclase and sheaths ranging in composition from a sodic oligoclase to albite. Biotite is strongly pleochroic, X-pale yellow, Z-deep reddish brown, 2V is less than 2 degrees. The refringence ($N_g = 1.690$) indicates an iron rich member of the annite-siderophyllite series.[2]

---

[1] Smith, G. O. and Calkins, F. C., *U. S. Geol. Sur., Snoqualmie Folio* No. **139**, 1906, p. 7.

The quartz-diopside veinlets are conspicuous in the outcrops immediately above the granodiorite. They are irregularly distributed, usually traversing the roof rock vertically although they may have no definite orientation. In general they vary from one quarter to two inches in width and attain a length of a few hundred feet. All the veinlets wider than one half inch show a distinct banded structure, a coarsely crystalline middle zone contrasting with fine grained, brownish gray borders. The central portion contains quartz, diopside and titanite, with minor amounts of apatite and zircon. It has a grain size of about 0.5 mm. and shows a gradual transition into the finer grained outer zones which consist of irregular clusters of leached biotite, quartz, diopside, titanite and a scant amount of magnetite. The average diameter of these segregations is about 0.5 mm. while that of the individual anhedra is but 0.03 mm. The outer fine grained borders of the veinlets are in reality transition zones grading, on the one hand inward toward the coarser central portions and, on the other hand outward into the schist. The larger, more euhedral minerals in the central portion of the veinlets appear to have been formed by the coalescing of the smaller grains. Similar features have been described with regard to recrystallized xenoliths.[3]

A few hundred feet along the highway toward the summit the character of the Guye formation changes from a biotite schist to a metamorphosed basalt. Here the old lava is conspicuously porphyritic with tabular labradorite phenocrysts as much as 4 cm. in length. These crystals, which are severely fractured and contorted, are partially replaced with chlorite and epidote. The groundmass contains small laths of labradorite and shows the same type of alteration.

---

[2] Winchell, A. N., Elements of Optical Mineralogy, p. 368, **1927.** Part II.

[3] Goodspeed, G. E., *Jour. Geol.*, vol. **35,** no. 7, Nov. 1927. Effects of inclusions in Small Porphyry Dikes at Cornucopia, Oregon.

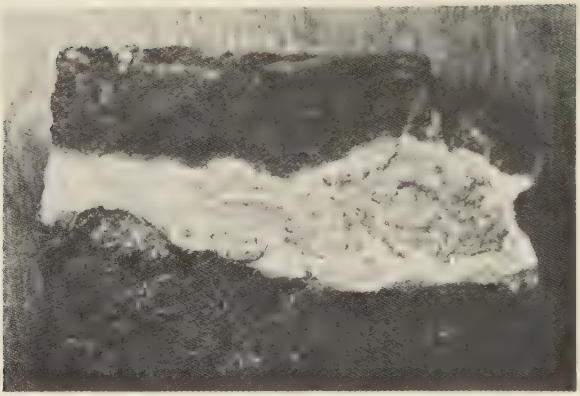


FIG. 1. Garnet-rich veinlet with transitional zones into schist. Cornucopia, Oregon. Natural size.

Where the quartz-diopside veinlets traverse these metamorphosed basic lavas their mineral composition is radically changed. Calcite appears as a late mineral. Garnet becomes noticeable, and in some veinlets may exceed 50 per cent of the mineral composition. With this increase in garnet there is a corresponding decrease in diopside and titanite. The amount of quartz varies from 0–50 per

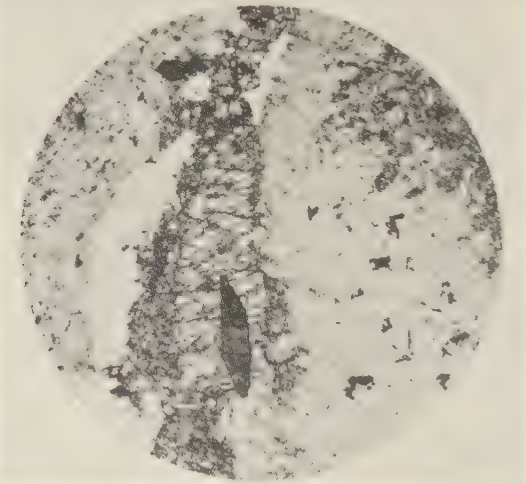


FIG. 2. A section showing the coarsely crystalline middle zone of clear quartz and dark, euhedral titanite surrounded by diopside. The same minerals appear on the margins of the middle zone but of considerably smaller dimensions. Snoqualmie Pass, Washington. 12×.

cent. In the calcite-rich veinlets it is lacking or not over 5 per cent. In others it equals the amount of garnet.

Structures similar to those of the quartz-diopside veinlets prevail. There are, however, some minor differences such as a coarser central band of diopside in the midst of the quartz and garnet of the middle zone. Another feature peculiar to the garnet veins is a small but definite band of kaolinitic material along the outer margin of the transition zone and the country rock. It persists as an irregular band of fine, cloudy material averaging 0.15 mm. in width wherever the veinlets traverse the basic lavas. It is lacking where they traverse the schist. Another noteworthy feature is the presence of chlorite and pyrite commonly occurring in the upper reaches of the veins several hundred feet above the actual granodiorite contact.

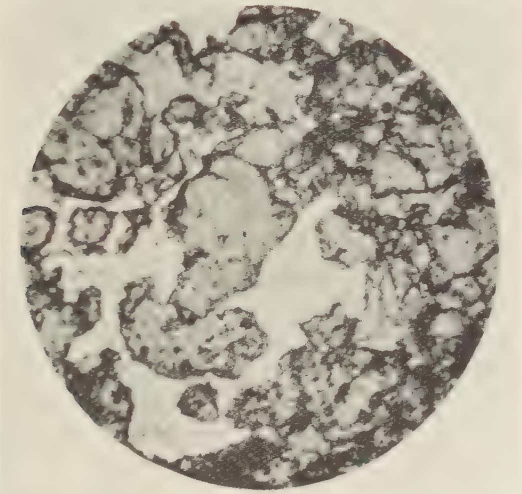


Fig. 3. Section of a garnet-rich veinlet showing later quartz and calcite. Cornucopia, Oregon. 35×.

As previously described, the growing together of smaller individuals to form the larger crystals appears to be an important mechanism of formation. Kaolinitic material and the presence of such minerals as chlorite suggests lower temperature hydrothermal solutions.

Cornucopia Occurrence

The quartz-diopside-garnet veinlets occurring in the vicinity of

Cornucopia, Oregon, are practically identical with those just described. At Cornucopia a late Mesozoic granodioritic batholith invades a series of metamorphic rocks consisting largely of biotite and hornblende schists. Some of the schists, known locally as greenstones, approach hornfels in megascopic characteristics.

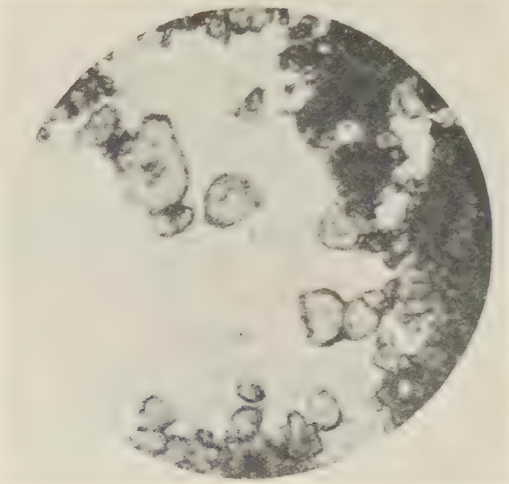


FIG. 4. Another portion of the garnet phase showing a basal section of quartz surrounded by calcite. Snoqualmie Pass, Washington. 35×.

Near Red Mountain, where the veinlets are well shown, the invaded rock is xenoblastic schistose, fine grained (0.07 mm.) and consists chiefly of hornblende and plagioclase with or without biotite. Mafics usually constitute 50 per cent and the quartz and plagioclase 25 per cent each. The plagioclase is oligoclase (An. 25). Distinct alignment of the mafics is evident.

In the vicinity of the Red Mountain contact the granodiorite exhibits a slightly gneissic structure. It is medium grained in texture and in section is seen to be hypautomorphic-granular with elongated clusters of biotite and much finer bands of quartz and feldspar. At the immediate contact the uneven texture is much more accentuated, the finer grained bands of quartz and feldspar composing about 40 per cent. The approximate mineral composition is about 65 per cent albite-oligoclase, 15 per cent quartz, 10 per cent biotite and hornblende and 5 per cent orthoclase, with minor amounts of apatite and zircon. The alteration products, which compose about 5 per cent, include sericite, epidote, chlorite, zoisite and kaolinitic material. At the contact hornblende as well as biotite is present and these minerals constitute about 20 per cent of the rock. The biotite is apparently replacing the hornblende. The outer sodic rims of the plagioclase are very clear as contrasted with the cloudy cores.

The quartz-garnet-diopside veinlets, in general, exhibit the same features as those from the Cascade locality but in the field their contacts appear to be clean cut and sharp. In thin section, however, no line of demarcation is discernible, merely a short transition from the wall rock into the veinlet. Biotite is changed to hornblende at the contact and this, in turn, is changed to diopside. Approaching the contact the feldspar and quartz become increasingly cloudy and indistinguishable, finally merging into a fine "ragged" textural border zone. However, even within the veinlet an alignment, inherited from the schist, is discernible. Coarse crystallization prevails in the middle zone where irregular groups of garnet appear. Coarsely crystalline garnet and diopside also occur in irregular and in transverse veinlets within the main one. The earlier garnet, forming the walls of these veinlets, appears to be somewhat altered along the immediate borders of the cross veinlets.

CONCLUSIONS

In his studies of the granitic contacts of the Pyrenees, Lacroix mentions dikes filled with "garnetites" or "epidosites" and classified them as aplitic or pegmatitic dikes.[4] It is doubtful if the term 'dike' could be applied to the veinlets just described as their mechanism is one of replacement rather than fissure filling.

The contact of these veinlets, their texture and the evident aggregation of smaller individuals into larger crystals (an increase in size of about 16 times) indicate an ease of recrystallization which was probably caused by the hot emanations from the granodioritic intrusives. While some calcium and titanium were doubtlessly derived from these emanations, the actual mineral suite of the veinlets was much influenced by the chemical character of the rocks traversed and replaced. As might be expected, garnet and calcite are most abundant in these veinlets, or portions of veinlets, which cut more basic rocks such as altered lavas.

[4] Lacroix, A., Le Granite des Pyrenees et ses phenomens de Contact: *Carte Geologique de France,* tome **10,** no. 64, 1898–1899.

Coarsely crystalline veinlets within the main veinlets may be explained by the filling of shrinkage cracks under lower temperature conditions, which are further evidenced by the kaolinitic borders along these later veinlets. It seems probable that these phenomena were formed by conditions ranging from pyrometasomatism to hydrothermal alteration. Similar conclusions with regard to contact silicates were reached by Agar in his studies of contact metamorphism in the western Adirondacks.[5]

[5] Agar, W. M., *Proc. Am. Phil. Soc.*, vol. **62**, pp. 95–174, 1923, Contact Metamorphism in the Western Adirondacks.

THE PREPARATION OF THALLOUS FORMATE

J. S. Vhay and A. T. Williamson, *Princeton University.*

Introduction*

Thallous formate is extremely useful in petrographic laboratories because its aqueous solutions are liquids of densities which rise to 3.5 on saturation, properties which make such solutions important both for the separation of minerals of varying density and the determination of densities of individual minerals. The saturated solution is fairly stable, and may be diluted within certain limits; concentration to a density greater than 3.5 may be obtained by saturating at a higher temperature and using the solution at that temperature.[1]

These desirable qualities are offset by the high market price of the compound, and this paper was written at the suggestion of Dr. Sampson to see whether the compound could be prepared in an ordinary laboratory by a comparatively economical process.

The principle of the method finally decided upon is to dissolve metallic thallium in sulphuric acid, and add barium formate, which precipitates barium sulphate and leaves thallous formate. In Miss Vassar's paper[2] on Clerici solution, two methods of preparing thallous carbonate are described, and thallous formate can be formed easily from the carbonate by adding formic acid; but it is believed that the following method is simpler.[3]

---

* For general information on thallium, see A. V. Petar, Thallium, *U. S. Bur. Mines, Information Circular* **6453**, 1931.

[1] Such hot solutions cannot be used with magnetite and similar minerals, as it was found that the thallous formate was decomposed. H. Vassar found the same thing true with respect to sulphides. (*Am. Min.*, vol. **10**, p. 123, 1925).

[2] *Op. cit.*, p. 124.

PROCEDURE

The raw material consisted of sticks of metallic thallium about half an inch in diameter. They were dissolved in sulphuric acid,[4] the reaction being largely:

$$(1)\quad 2Tl + H_2SO_4 \rightarrow Tl_2SO_4 + H_2, \text{ and}$$
$$(2)\quad 2Tl + 2H_2SO_4 \rightarrow Tl_2SO_4 + 2H_2O + SO_2.$$

Due to the dilution of the acid used, the first equation represents the preponderating reaction, and it was found that the use of the recommended metal-acid ratio was sufficient to dissolve the metal completely.[5] The reaction was carried on at 100 C. by leaving the mixture on a hot water bath, and was complete within twenty-four hours.

The thallous sulphate so formed is not very soluble, so it is best to keep the solution at 100°C., at which temperature 185 grams can be dissolved in a litre of solution. It may be necessary to add more water to prevent the separation of crystals.

The next step requires barium formate, and this can be easily prepared by boiling an aqueous suspension of barium carbonate with a slight excess of concentrated formic acid.[6] This will often leave a residue of siliceous impurities, which should be separated by filtering.

The third step calls for careful attention to detail, if time is to be saved subsequently The boiling dilute solution of barium formate is added slowly to the boiling solution of thallous sulphate with constant stirring After adding enough to produce almost complete reaction, the precipitate is allowed to settle, and small quantities of hot barium formate solution are added to the pale yellow supernatant liquid until such an addition fails to give a fresh precipitate of barium sulphate.

---

[3] Another method of forming thallous formate is described in "Methods of Preparing and Cleaning some common heavy liquids used in ore testing" by R. G. O'Meura and J. B. Clemmer (*U. S. Bur. Mines, Rept. Investigations* **2897**, 1928), but it also is rather long.

[4] For every 100 grams of Tl use 20 cc. of concentrated H_2SO_4, diluted 1:6.

[5] A small amount of black, insoluble residue remaining probably represents certain impurities in the raw material, but it is not necessary to filter it off.

[6] For 100 grams of Tl use 73 grams of $BaCO_3$.

The main reaction is:

(3) $Tl_2SO_4 + Ba(HCOO)_2 \rightarrow 2HCOOTl + BaSO_4$,

but since the thallous sulphate solution contained a slight excess of free sulphuric acid, the following reaction will take place simultaneously:

(4) $H_2SO_4 + Ba(HCOO)_2 \rightarrow 2HCOOH + BaSO_4$.

The mixture is now boiled for about an hour and allowed to stand for a day or two. This will favor the growth of crystalline barium sulphate, and make separation of the residue much easier.

The solution, which contains thallous formate and formic acid, is decanted through a Buchner funnel which should be equipped with hardened filter paper. The barium sulphate is shaken with water slightly acidulated with formic acid, and these washings are also passed through the filter. Finally the barium sulphate is brought onto the filter, and washed thoroughly with the dilute formic acid.

The combined filtrates and washings are now heated on a water bath, and evaporated to dryness; evaporation may be accelerated with the help of a gentle stream of warm air directed at the surface of the liquid. More water is then added, and the process is repeated until the odor of formic acid has disappeared. Due to the common ion effect, free formic acid precipitates thallous formate before the maximum density can be attained, so it must be eliminated before making up the final solution. The crystals of thallous formate can then be dissolved in a small quantity of warm water and brought to the required density by evaporation or dilution.

Reconcentration of Dilute Solutions

In using thallous formate solutions for mineral separation dilute solutions of washings accumulate. It will probably be found that a fine yellow precipitate forms in these washings; this is due to the fact that when saturated solutions of thallous formate are diluted beyond a certain limit, hydrolysis results in the formation of insoluble complex salts. Since reconcentration can only reverse the process after prolonged treatment, it was found best to proceed according to the following method. The solution with its suspended residue is placed on a water bath, and enough formic acid is added to dissolve the precipitate. It is then evaporated to dryness and held on the water bath until the odor of formic acid has disappeared, after which the amount of water necessary to form a solution of high density is added to the crystals of thallous formate.

This method was used successfully in reworking several batches of discarded solutions which had been contaminated with the hydrolyzed salt.

MATERIALS

The price of thallium metal has fluctuated greatly. That used for this investigation was obtained from Eimer and Amend, New York, at a cost of $17.00 for 500 grams, in November, 1931. The cost of the other materials is slight; and since 100 grams of the metal will yield almost exactly the theoretical 122 grams of thallium formate, the price per 100 grams of the formate is about $3.00 at the above price of thallium.[7]

[7] To obtain 100 grams of thallous formate (HCOOTl), we require:

Substance	*Amount*	*Price*
Tl	82 grams	$2.80
Conc. H_2SO_4	16 cc.	.02
$BaCO_3$	60 grams	.12
87% HCOOH	28 cc.	.05
		$2.99

THE BEARDSLEY METEORITE

H. H. NININGER, *Denver, Colorado.*

To the long list of Kansas meteorites this will add another, bringing the total number up to 22 falls for that state.

On October 15, 1929, the residents in the vicinity of Beardsley and surrounding villages to a distance of 40 miles or so were startled by a dazzling light followed by the usual thunderous sounds about 11:30 P.M. Those who were abroad at that hour saw a fire-ball pass from E.S.E. to W.N.W. and disappear at a considerable altitude. Unfortunately no scientist visited the locality until almost two years later so that the data are not as definite as they might have been.

In the village of Beardsley Mrs. Ray Gaines leaned out of the open window on the north side of the house and heard distinctly the fall of two stones, one of which seemed to fall in the yard. A whizzing noise was heard preceding each impact. A search was made by the Gaines' during the next few days and two stones were found, one of 4 oz. about 20 meters east of the house was evidently one of those heard to strike. The other was found some 40 rods to the east and a little south of the house. This one weighed slightly less than 2 lbs. and lay on top of the lately sown wheat ground. It is very doubtful if this was the second stone heard by Mrs. Gaines who is quite certain that the one she heard fell to the north of the house.

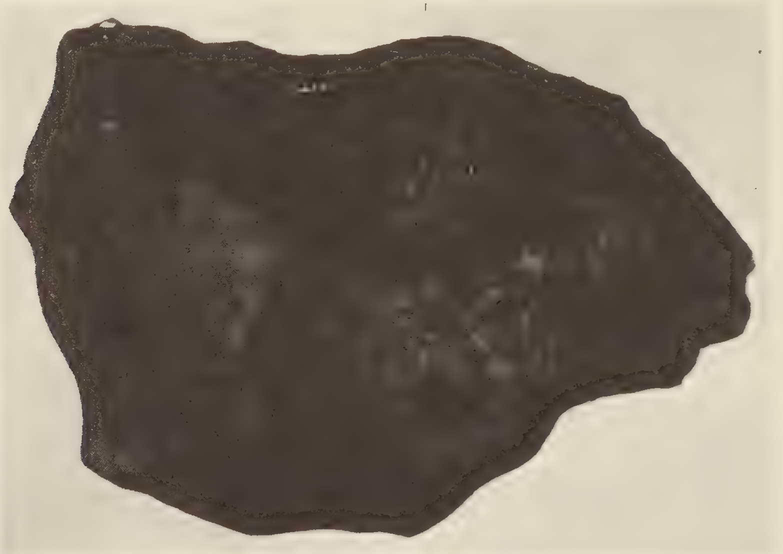


Fig. 1. View of the largest Beardsley stone showing tendency to orientation during flight.

The writer was in central Mexico at the time of this occurrence and word did not reach him until his return in late December. By this time the two stones had been sold to a collector in the east who was making an effort to recover any other stones which may have fallen, hence the writer did not visit the locality until August, 1931, after being informed by the party that the two stones constituted in his opinion the entire fall.

On August 10, 1931 I instituted a search by a visit to the village of Beardsley and during the next 60 days was rewarded by securing six masses weighing respectively 15, 2.5, 8.4, 10.6, 43, and 328 oz. Some of these had been in the possession of their finders since October, 1929. Others were found during the autumn plowing which was in progress at the time of my several visits during August and September.

All but the largest stone were found entirely on top of the ground. Three were found in pasture land the others on cultivated soil. The large stone was struck by the plow. Its upper surface lying at a depth of a little less than four inches.

The stones which were found two years after the fall seemed to be preserved about as well as those which were picked up within a few days of their arrival.

All of the stones are covered with the usual dark slaty grey fusion crust. Those which have lain exposed on the surface for two years have changed to almost jet black color where not in contact with the soil.

Most of the stones show a few small spots or streaks of brown stain, from oxidation, on certain portions of the fusion crust. These stains were less prevalent on a small stone picked up by the writer, September 15, 1931, than on some of those found earlier.

The crust is in most cases 0.25 mm. thick or less and is checked into polygonal areas of 2 to 10 sq. mm. In a number of places this crust also shows flowage lines. The large specimen of 9285 grams is fairly well oriented showing abundant pittings of the usual type. The crust is usually quite dull but in a very few places shows glossy black patches a few square mm. in size.

With two exceptions the eight stones recovered appear to be almost complete individuals, being covered with a crust of uniform thickness and showing no indication of late fragmentation; but the 2.5 oz. specimen appears to be the result of a break near the middle of an elongated mass upon its impact with the soil, while the 10.6 oz. specimen is very angular and shows one fresh fracture and apparently five degrees of fusion on as many remaining sides.

Where the crust was broken at the time the stones were found the interior shows abundant brown stains of oxide marking the locations of metallic grains; but where broken afresh the color of the interior varies from light ashy grey to dark mottled steel grey. In the 43 oz. stone where the finder hammered off a small piece it broke along a dark mottled surface exposing a slickenside which indicates quite definitely a faulting along a slightly undulating plane.

A small individual was cut exposing, in four polished sections, about 30 sq. cm. Also three thin sections were made. One slice and three sections were turned over to Mr. W. A. Waldschmidt of the Colorado School of Mines for a petrographic study.

An interesting fact concerning the Beardsley fall is its relation in point of time to three other falls within the bounds of the eastern half of the United States, namely, the North Carolina fall of July 9, 1929; Paragould, Arkansas, Feb. 16, 1930; and the Miller, Arkansas, fall of July 13, 1930. These constitute an unusual record of four falls (stones from which were recovered) within a twelve months period, or to be more exact a period of 369 days. If this area were taken as an index to the number of falls arriving on the lithosphere within the period under consideration, we should have to conclude that 532 falls landed on the earth during those twelve months. As a matter of fact it is practically certain that less than half of the falls which occur in any area, such as the eastern half of the United States, are ever found. It is also possible that those four might represent an unusual concentration of meteoric impacts.

PETROGRAPHY OF THE BEARDSLEY METEORITE

W. A. Waldschmidt

The portions of the Beardsley aerolite available for petrographic study were three thin sections and a thin slice about three centimeters square. The thin sections show that olivine and enstatite constitute about sixty per cent (estimated) of the aerolite, and that the remaining forty per cent consists of nickel-iron with minute inclusions of pyrrhotite. Olivine occurs primarily as anhedral grains, but a few grains have subhedral outlines. The majority of the olivine grains are small and are grouped together in chondrules and irregularly shaped masses which serve as a matrix for the alloy. The olivine grains with subhedral outlines are considerably larger than the anhedral grains surrounding them. This is true of the olivine in the chondrules as well as of that in the main mass. (Fig. 2, C.) Enstatite, though not abundant, occurs as lath-shaped to fine fibrous, radiating masses and chondrules. Two of the enstatite chondrules are shown in Fig. 2, B and D. Fracturing at right angles to the long direction of the lath-shaped crystals, is quite pronounced, but is poorly defined in the fine fibers. Mixtures of enstatite and olivine grains were not observed in the sections examined.

The thin slice was polished and examined with a metallographic microscope for the purpose of studying the relationships of the minerals and metals present. Pyrrhotite occurs only as small particles, most of which are included within the nickel-iron and a few of which are included in the olivine. An interesting relationship between the metallic grains and olivine is the variation in smoothness of the contacts. In some places the contact between the olivine and nickel-iron is decidedly smooth and in other places it is decidedly jagged and irregular. These variations may occur along the same line. Particles of olivine with relatively smooth outlines are included in many of the metallic grains. The relationships just described are illustrated in the photomicrographs, Figs. 3 and 4.

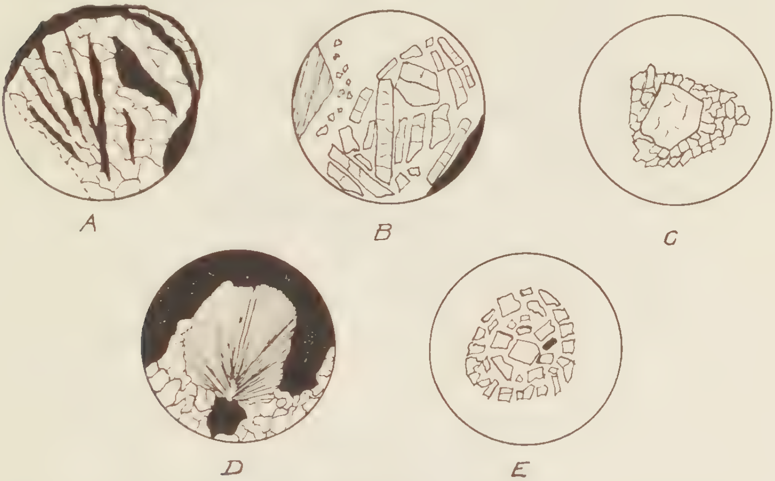


FIG. 2. Drawings by W. A. Waldschmidt showing microscopic appearance of several chondrules.

A. Olivine chondrule showing anhedral character of the olivine, and also included and surrounding black metallic material.

B. Enstatite chondrule, showing the lath-shaped character of the crystals. A portion of a fine fibrous enstatite is shown at the left, and between the two enstatite areas are a few anhedral grains of olivine.

C. Olivine chondrule with a central subhedral olivine grain.

D. Enstatite chondrule with fine fibrous radiating structure. In this chondrule the fibers radiate from a point on the edge instead of from a central point.

E. Olivine chondrule with a central anhedral grain surrounded by two concentric rings of anhedral grains. The concentric arrangement is more evident in the thin sections because of the brown color induced by limonitic alteration.

Alteration has progressed sufficiently to give the rough fracture surfaces of the aerolite a gray to brown stony appearance. Metallic material can not be readily distinguished in the fractured surfaces, but after polishing it may be seen constituting a large portion of the mass. The alteration product is limonitic in character and has evidently been formed from the alloy. The olivine and enstatite aggregates and chondrules, studied in the thin sections, do not show any marked alteration, but do show a brown discoloration where the limonitic material has penetrated into the fractures and

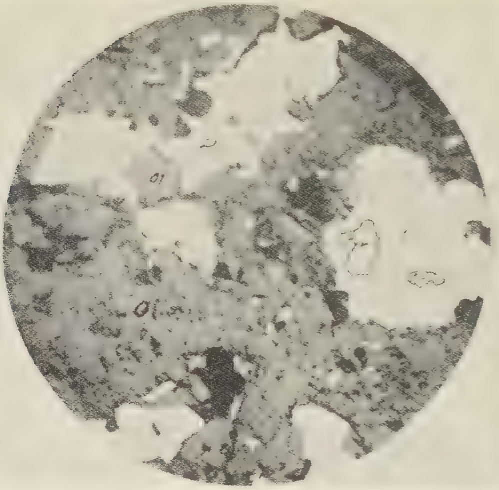


Fig. 3. Photomicrograph of the Beardsley aerolite. Ol. Olivine; P. Nickel-iron; Pyr. Pyrrhotite. The pyrrhotite grains in the nickel-iron have been outlined in this figure, and in fig. 4. 60×.

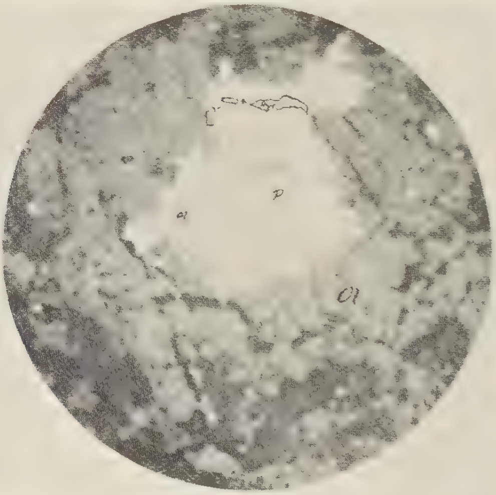


Fig. 4. Photomicrograph of the Beardsley aerolite. Ol. Olivine; P. Nickel-iron; Pyr. Pyrrhotite. This photomicrograph illustrates the variation in smoothness of the olivine-metallic contacts. 60×.

between the crystalline grains. The darkest discolored areas of pyroxene and olivine are adjacent to the outlines of the metallic grains but the color gradually decreases toward the center of the areas.

NOTES AND NEWS

CHARLES-FRANCOIS DU FAY, A PIONEER IN CRYSTAL OPTICS

Adolf Pabst, *University of California.*

The foundations for correlation of the optical properties of crystals with their form or symmetry were laid in the second decade of the nineteenth century by Biot and Brewster.[1] Their success depended on the use of polarized light. Haüy had attempted to distinguish between singly and doubly refracting crystals and had correlated optical isotropism with certain highly symmetrical *molécules intégrantes*, but his method, observing the image of a pin through crystal prisms, could not lead to satisfactory results.

Some eighty years before Brewster the first correlation of crystal form and optical properties was attempted by Charles-Francois de Cisternai du Fay. Unfortunately his early death prevented the full publication of his results and the only knowledge we have of his work is from the *éloge* written by de Fontenelle, at that time *secrétaire perpétuel* of the Academie.[2]

Du Fay was born in Paris, September 14, 1698, of a family long accustomed to the profession of arms. He also entered the military service, but after a brief career as a lieutenant he began to devote himself to chemistry and in 1723, at a remarkably early age, he became a member of the Academie des Sciences as a chemist. During the next fifteen years he was active in all the branches of science then recognized and made important contributions to the Memoires of the Academie. His best-known work was in the fields of electricity and phosphorescence, and this is usually cited in the histories of physics. Within a few years he attained such a reputation as a successful experimenter that he was engaged by the royal council to work out chemical tests for the quality of dyes.

In 1732 the king appointed du Fay superintendent, *intendant*, of the royal gardens and in this capacity he was an active botanist until his death, July 16, 1739, after a brief illness. It must have been during these last years that he did his work on the optical properties of crystals.

The *éloge* by de Fontenelle is charmingly written with many sidelights on the conditions of the time and interesting reflections on international scientific cooperation and the relations of scientists and diplomats. In figure 1 is reproduced that page of the *éloge* which contains the mention of du Fay's work on crystals. The paragraph of chief interest, freely translated, follows.

---

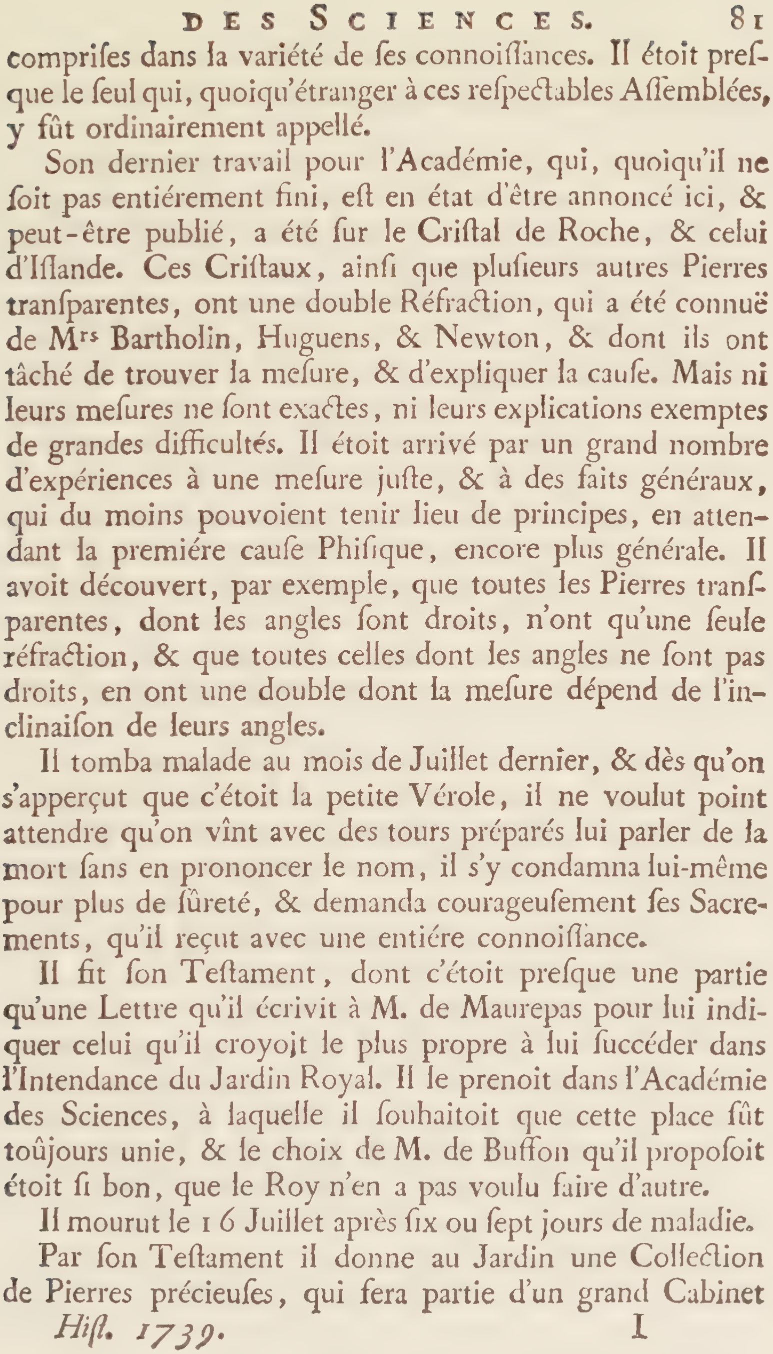
[1] David Brewster, On the laws of polarization and double refraction in regularly crystallized bodies: *Phil. Trans. Roy. Soc. London*, **1818**, pp. 199–273.

[2] Histoire de l'Academie Royale des Sciences, **1739**, pp. 73–83, *Paris*, 1741.

> His last work for the academy, which, though not quite complete, is far enough advanced for announcement and possibly for publication, has been on rock crystal and iceland spar. These crystals, like many other transparent stones, have a double refraction which was known to Bartolinus, Huyghens and Newton and which they tried to measure and explain. But neither are their measurements exact, nor their explanations free from great difficulties. By a great number of experiments he arrived at exact measurements and general facts, which however, considering the first physical cause, may represent even more general principles. He discovered, for instance, that all transparent stones which have right angles are but singly refracting, whereas those whose angles are not right angles are doubly refracting and that the measure of their double refraction depends on the inclination of their angles.

De Fontenelle does not state the basis for these remarks but it seems certain that he must have had before him some notes or unfinished manuscript. Being a poet he probably was little able to interpret or to judge du Fay's work. One wishes for a more complete report. By what means did du Fay arrive at better determinations of refraction than his forerunners? Just what fault did he have to find with their explanations? If his notes or manuscript can be found it would be most desirable to have them made available.

Under the circumstances it is impossible to say how far the erroneous or ambiguous statements in the quotation above are due to du Fay and how far they are due to the author of the *éloge*. In any event it is certain that du Fay should be credited with a great achievement. It seems that he discovered the optically isotropic character of isometric crystals, the anisotropic character of all other crystals, and the fact that the amount of birefringence is, in general, different for each species. He had taken the first steps toward a correlation of crystal form and optical properties. The knowledge of his predecessors was limited to the fact that calcite



DES SCIENCES. 81

compriſes dans la variété de ſes connoiſſances. Il étoit preſque le ſeul qui, quoiqu'étranger à ces reſpectables Aſſemblées, y fût ordinairement appellé.

Son dernier travail pour l'Académie, qui, quoiqu'il ne ſoit pas entiérement fini, eſt en état d'être annoncé ici, & peut-être publié, a été ſur le Criſtal de Roche, & celui d'Iſlande. Ces Criſtaux, ainſi que pluſieurs autres Pierres tranſparentes, ont une double Réfraction, qui a été connuë de Mrs Bartholin, Huguens, & Newton, & dont ils ont tâché de trouver la meſure, & d'expliquer la cauſe. Mais ni leurs meſures ne ſont exactes, ni leurs explications exemptes de grandes difficultés. Il étoit arrivé par un grand nombre d'expériences à une meſure juſte, & à des faits généraux, qui du moins pouvoient tenir lieu de principes, en attendant la premiére cauſe Phiſique, encore plus générale. Il avoit découvert, par exemple, que toutes les Pierres tranſparentes, dont les angles ſont droits, n'ont qu'une ſeule réfraction, & que toutes celles dont les angles ne ſont pas droits, en ont une double dont la meſure dépend de l'inclinaiſon de leurs angles.

Il tomba malade au mois de Juillet dernier, & dès qu'on s'apperçut que c'étoit la petite Vérole, il ne voulut point attendre qu'on vînt avec des tours préparés lui parler de la mort ſans en prononcer le nom, il s'y condamna lui-même pour plus de ſûreté, & demanda courageuſement ſes Sacrements, qu'il reçut avec une entiére connoiſſance.

Il fit ſon Teſtament, dont c'étoit preſque une partie qu'une Lettre qu'il écrivit à M. de Maurepas pour lui indiquer celui qu'il croyoit le plus propre à lui ſuccéder dans l'Intendance du Jardin Royal. Il le prenoit dans l'Académie des Sciences, à laquelle il ſouhaitoit que cette place fût toûjours unie, & le choix de M. de Buffon qu'il propoſoit étoit ſi bon, que le Roy n'en a pas voulu faire d'autre.

Il mourut le 16 Juillet après ſix ou ſept jours de maladie.

Par ſon Teſtament il donne au Jardin une Collection de Pierres précieuſes, qui fera partie d'un grand Cabinet

Hiſt. *1739.* I

FIG. 1. Facsimile of a page from the *éloge* of du Fay. Slightly reduced.

and quartz are birefringent. At that time when no attempt at crystal classification had yet been made and when testing for birefringence by polarized light was unknown, he could hardly be expected to accomplish more.

Du Fay has been sadly slighted by the historians of crystallography, probably because of the unusual and incomplete manner in which his results were published. Groth[3] fails entirely to mention him. Kobell[4] mentions him only for his work on phosphorescence.

As previously stated he is mentioned by several historians of physics. So far as the writer is aware only one of these, Edmund Hoppe,[5] refers to du Fay's work on the optics of crystals.

---

[3] P. Groth, Entwicklungsgeschichte der Mineralogischen Wissenschaften, *Berlin*, **1926.**

[4] F. von Kobell, Geschichte der Mineralogie, pages 32 and 70, *Munich*, **1864.**

[5] Edmund Hoppe, Geschichte der Physik. p. 260 *Braunschweig*, **1926.**

Professor Edward H. Karus, Director of the Mineralogical Laboratory at the University of Michigan, was elected an honorary member of the German Mineralogical Society at a meeting held at Frankfurt on Sept. 23.

Dr. Frederick Henry Hatch, a past president of the British Institution of Mining and Metallurgy and a member of the governing body of the Imperial Institute, died on Sept. 22, at the age of sixty-eight years.

Professor Ulysses Sherman Grant, Head of the department of Geology and Geography of Northwestern University, died at the age of sixty-five on Sept. 21, after a short illness and operation.

Adolph Lomb, vice-president of the Bausch & Lomb Optical Co., died at his home in Pittsford, N. Y., a suburb of Rochester, on Sept. 30th, after a brief illness. He was sixty-six years old.

The death was announced of Dr. Adolf Sauer, professor of mineralogy and geology at the University of Stuttgart, also of Dr. Otto Mügge, professor of mineralogy at Göttingen.

Dr. George I. Adams, head of the department of geology in the University of Alabama, died on September 8 at the age of sixty-one years.

Dr. Adam C. Gill, Emeritus Professor of Mineralogy and petrography at Cornell University, where he had served since 1894, died on Nov. 8, at Ithaca, New York, at the age of sixty-nine years.

Attention is called to the Thirteenth Annual Meeting of The Mineralogical Society of America to be held at Harvard University, December 28–30, 1932, and to the *preliminary* list of titles of papers to be presented at this meeting, printed in this issue.

BOOK REVIEWS

PROSPECTING FOR GOLD. Third Edition. Ion L. Idriess, x+272 pages, 22 illustrations. Angus & Robertson Ltd., Sydney, Australia; or Australian Book Co., *London*. Price 5 shillings.

Appearing first in March 1931 this book was so well received that a third edition of two thousand copies was prepared during March of this year. The latest edition has been enlarged by the addition of chapters on Reefing, Battery Works, Amalgamation, Cyaniding and Opal Mining. The main purpose is to prepare inexperienced men for prospecting and for working alluvial deposits of gold, tin and platinum. Some attention is likewise given auriferous reef prospection, stamp mill procedure, the amalgamation method and a brief note on the cyanide process. Twenty-four pages are devoted to a discussion of opal searching, extraction and sale.

The conversational style will appeal, no doubt, to the majority of people for whom the book has been prepared. Instructions are clear and detailed with an abundance of practical suggestions likely to save time and material. The importance of hydraulic sluicing is underlined and methods of treatment are considered in detail with the aid of some sketches. The author writes mainly in the hope of helping and stimulating intelligent prospection in Australia. However, this book should be highly useful to many people of various professions who are now seeking gold in this country. The modest price of the book places it within easy reach of anyone interested in the subject.

Robert W. Karpinski

THE MIAMI-PICHER ZINC-LEAD DISTRICT. Samuel Weidman with a chapter on Mining Methods by C. F. Williams and a chapter on Milling by Carl O. Anderson. University of Oklahoma Press, Norman Oklahoma. Price $2.50.

The Miami-Picher District is located in the northeastern corner of Oklahoma and is this state's portion of the larger and well known Tri-State District that includes Kansas, Missouri and Oklahoma. It produces 70% of the domestic production of zinc and 15% of the lead.

The present book is an excellent and timely treatise of the geology, mining and milling of this very important district. The major portion of the book, which treats of the geology and ore deposits, is written by Samuel Weidman, Professor of Geology at the University of Oklahoma. It is well organized and concise but comprehensive; a good summary of the existing literature plus Weidman's own field investigations. Maps, diagrams, and photographs are generously supplied and appropriate. Weidman favors the theory of magmatic origin of the ores, paying particular attention to the points most commonly criticized by the theory's opponents. C. F. Williams and Carl O. Anderson contribute authoritative chapters on mining methods and milling. A chapter containing a description of each mine in the district is included. The printing, paper, and binding are to be commended.

A. J. Eardley

THE MINERALOGICAL SOCIETY OF AMERICA

We have been able to secure reduced railroad fare for the Cambridge, Massachusetts, meeting December 28–29, 1932, by the round trip identification certificate method. This enables members to purchase before starting, round trip tickets for one and one half times the regular one way fare to Boston, not Cambridge. Tickets must be validated at Boston before beginning the return trip. It will be possible to go by one authorized route and return by another.

These identification certificates must be obtained before purchasing a railroad ticket. If you are going to Cambridge, write to the secretary *at once* for a certificate. Fellows of the Geological Society of America will be supplied direct from headquarters.

Frank R. Van Horn, *Secretary*,
Case School of Applied Science
Cleveland, Ohio.

THE MINERALOGICAL SOCIETY OF AMERICA

Thirteenth Annual Meeting

Alexander N. Winchell, *President*
Cambridge, Massachusetts
December 28–29, 1932

Program

In Joint Session with the Geological Society of America, Thursday, December 29, 1932, at 12 o'clock, noon.

A. N. Winchell, *Presidential Address:* **The New Mineralogy.**

List of Papers

To be presented Wednesday, December 28, 1932, after the business session at 2 P.M., and thereafter at the regular sessions on Thursday if not previously completed.

1. R. D. Butler and M. J. Buerger.—**Immersion Liquids of Intermediate Refraction.**
2. A. F. Rogers.—**The Symbols of Crystal Optics.**
3. A. F. Rogers.—**Cleavage and Parting in Quartz.**

4. C. B. Slawson.—A New Objective for the Petrographic Microscope.
5. G. Tunell, E. Posnjak, and C. J. Ksanda.—The Atomic Structure and Geometrical Constants of Tenorite.
6. J. D. H. Donnay and J. Mélon.—Haüy-Bravais Lattice and Other Crystallographic Data for Sodium Molybdo-Tellurate.
7. F. R. Van Horn and Kent R. Van Horn.—An X-Ray Study of Pyrite or Marcasite Concretions in the Rocks of the Cleveland, Ohio, Quadrangles.
8. A. C. Lane.—Five Fold Check of Uraninite Age?
9. M. J. Buerger.—The Pyrite-Marcasite Relation.
10. C. E. Tilley and J. F. Schairer.—Some Carnegieite Solid Solutions.
11. W. T. Schaller.—Johannsenite, a New Manganese Pyroxene.
12. R. E. Landon.—Colusite, A New Tin-Bearing Tennantite from Butte, Montana.
13. Phillip Krieger.—The Occurrence of Strontianite at Sierra Mojada, Mexico.
14. W. A. Tarr.—The Origin of the Sand Baritites of the Lower Permian of Oklahoma.
15. J. S. Stevenson.—Vein-Like Masses of Pyrrhotite in Chalcopyrite from the Waite-Ackerman-Montgomery Mine, Quebec.
16. P. F. Kerr. The Tungsten Deposit at Mill City, Nevada.
17. Stephen Richarz.—Peculiar Gneisses of a Late Formation in the Cascades, Washington.
18. Charles Palache and Edwin Over, Jr.—The Pegmatites of the Pikes Peak Region, Colorado.
19. A. F. Rogers.—Use of Plane Angles in Geometrical Crystallography.
20. J. D. H. Donnay. The Theory of Determinants Applied in Crystallography.
21. Charles Palache and Laurence La Forge.—Crystallographic Notes.
22. M. A. Peacock.—Crystallography of Emplectite.

INDEX TO VOLUME 17

Leading articles are in **Bold Face Type**; notes, abstracts and reviews are in ordinary type. Only minerals for which definite data are given are indexed.

Albitite from Shetland Isles. (Walker)................ 250
Alderman, A. R............... 39
Alkanasul (Westman).......... 495
Alleghanyite, optical, physical and chemical data........ 7
Allen, V. T., Galena replacing Pennsylvanian rootlet..... 156
Alling, H. L., Perthites........ 43
Ally, A. and Clark, G. L., X-ray examination of chrome ores 66
Aminoff, G.................. 251
Andrews, W. S., Biographical notice. (Palache)......... 78
Anorthoclase-bearing rock glass, changed composition of. (Hawkes, Harwood)...... 250
Anthophyllite series, variations in optical properties and composition. (Henderson, Ross).................. 114
Ardealite. (Schadler)......... 251
Arsenoklasite. (Aminoff)...... 251
Ashtonite, preliminary note and analysis. (Poitevin)....... 120

Babingtonite. (Palache, Gonyer) 114, 295
Ballmer, G. J., Native tellurium from N. Mexico.......... 491
Bandy, M. C. Castanite from Chile................... 534
Bannister, F. A............250, 455
Baringer Hill, Texas, pegmatite. (Landes)..........115, 381
Barite, microcrystals from Calif. (Howard)............... 120
Barite vein cutting granite of S. E. Missouri. (Tarr).....115, 443
Barth, Tom F. W., Chemical composition of noselite and haüyne.................. 466
Basaltic glass. (Fuller)........ 104
Bavenite, a beryllium mineral pseudomorphous after beryl, from Calif. (Schaller, Fairchild).................114, 409
Beardsley meteorite. (Nininger) 563
Becke, F. J. K., memorial of. (Kraus)................ 226
Beljankin, D. S.............. 252
Benn, J. H. Unusual feldspar crystals at Moneta, Va.... 492
Bentley, W. A. and Humphreys, W. J. Snow crystals. [Book review.]................. 123
Beringer, H. R. Simple determinative mineralogy. [Book review.]................. 494
Berman, H., Fibrous brucite from Quebec..........114, 313
Bird, P. H., New occurrence and x-ray study of mosesite..................... 541
Block structure in crystals, significance of. (Buerger).... 177
Bloedite, refractive indices of. (Schaller)............... 530
Braggite, a new platinum mineral..................... 455
Brine content of negative crystal cavities of galena. (Buerger)............... 228
Brookite crystals, tabular parallel to base. (Phillips).... 39
Brucite, dehydrated, structure of. (West)............... 316
Brucite, fibrous, from Quebec. (Berman).............114, 313
Brugnatellite................. 350
Buerger, M. J. Cleavage surfaces of galena........... 391
——— **Negative crystal cavities of galena and their brine content**........... 228
——— **Significance of block**

structure in crystals....... 177
Bulfonteinite, a new fluorine-bearing hydrous calcium silicate from S. Africa. (Parry, Williams, Wright). 455

Calaverite and the law of complication. (Peacock)....... 317
Calcite, manganese-bearing. (analysis)............... 5
Ca_2SiO_4 and Mn_2SiO_4, mix-crystal of. (Greer)........ 135
Camsellite................... 509
Castanite from Chuquicamata, Chile. (Bandy)........... 534
Cebollite, new optical data...349, 356
Celsian..................... 171
Cesium biotite from Custer Co., S. Dakota. (Hess, Fahey). 173
Chalcopyrite and pyrite inclusions in sphalerite. (Shenon)............... 514
Chrome ores, x-ray examination of. (Clark, Ally)....... 66
Chudoba, K. Die Feldspäte und ihre practische Bestimmung. [Book review.]..... 456
——— Mikroskopische Charakteristik der gesteinbildenden Mineralien. [Book review.].................. 456
Clark, G. L. and Ally, A., X-ray examination of chrome ores. (1) Lattice dimensions. (2) Theoretical densities.................. 66
Cleavage surfaces of galena. (Buerger)............... 391
Clerici's solution, restandardization of. (Hawkins)...... 157
Clinoptilolite, a new species. (Schaller)............... 128
Collophane, detrital. (Martens) 153
Complication, law of. (Peacock) 317
Connecticut, minerals of. (Schairer) [Book review.]. 200
Coombs, H. A. and Goodspeed, G. E., Quartz- diopside-garnet veinlets........... 554
Cooperite, crystal structure of. (Bannister).............. 455
Correct and incorrect statements of crystallographic theory in current textbooks. (Tunell, Morey)... 365
Creedite from Nevada. (Foshag) 75
Crystal structure models, new method of building. (Gruner)................ 35
Cuprotungstite, chemical composition of. (Schaller)..... 234

Dana's Textbook of mineralogy. [Book review.]....... 539
Desericitization: a process operative during high-temperature mineralization. (Landon)................ 449
Descriptive petrography of the igneous rocks. (Johannsen) [Book review.]........... 41
Deuteric and later alterations of uncompahgrite. (Goranson, Larsen)................. 343
Diamond twin, multiple. (Palache).................. 360
Diopside-quartz-garnet veinlets. (Goodspeed, Coombs) 554
Dittler, E.................. 495
Drugman, J. E............... 455
Dryden, Lincoln, Heavy minerals of Maryland coastal plain.................... 518
du Fay, Charles-Francois, pioneer in crystal optics. (Pabst)................. 569

Eakle, A. S., memorial of. (Schaller)............... 94
Eardley, A. J. Book review..... 573
Eckel, E. B., Garnet as an amygdule mineral......116, 522
Edson, F. C., Heavy minerals as a guide in stratigraphic studies................116, 429
Ellsworth, H. V., Gadolinite

from Frontenac Co., Ont. . . 96
——— **Monazite colored by carbon, from Nipissing district, Ont.** 19
Erzmikroskopischen Bestimmungstafeln. (Schneiderhöhn, Ramdohr) [Book review.] 83
Examination of fragmental rocks. (Tickell) [Book review.] 40

Fahey, J. J. and Hess, F. L., Cesium biotite from S. Dakota 173
Fairbanks, L. E. [Book review.] 40, 494
Fairchild, J. G. and Schaller, W. T., Bavenite 409
Feldspäte und ihre practische Bestimmung. (Chudoba) [Book review.] 456
Feldspar crystals, unusual. (Benn) 492
Ferrotremolite, oxyhornblende and tourmaline. (Winchell) 114, 472
Flattened minerals in muscovite at Spruce Mine, N. Car. (Hall) 115
Ford, W. E., Dana's Textbook of mineralogy. [Book review.] 539
Foshag, W. F., Creedite from Nevada 75
———**and Palache, C., Chemical nature of joaquinite** 114, 308
Fuller, R. E., Basaltic glass 104

Gadolinite from Frontenac Co., Ont. (Ellsworth) 96
Galaxite, a new spinel 15
Galena, cleavage surfaces. (Buerger) 391
Galena replacing Pennsylvanian rootlet. (Allen) 156
Garnet as an amygdule mineral. (Eckel) 116, 522
Garnet-diopside-quartz veinlets. (Goodspeed, Coombs) 554
Gems and gem materials. (Kraus, Holden) [Book review.] 124
Gildersleeve, B., Some stages in disintegration of glauconite 98
Gillespite 170
Gilluly, J. and Reed, J. C., Heavy minerals of plutonic rocks of eastern Oregon . . . 201
Glaucocerinite. (Dittler, Koechlin) 495
Glauconite, stages in disintegration of. (Gildersleeve) . . 98
Gold crystals, euhedral, from Mariposa Co., Calif. (Rogers) 115
Gonyer, F. A., Irving, J. and Vonsen, M. Pumpelleyite from California 338
——— **and Palache, C., Babingtonite** 114, 295
——— **New iron meteorites from Chile and Texas** 357
Goodspeed, G. E. and Coombs, H. A., Quartz-diopside-garnet veinlets 554
Goranson, E. A. and Larsen, E. S., Deuteric and later alterations of the uncompahgrite of Iron Hill, Col. . . 343
Greer, W. L. C., Mix-crystals of Ca_2SiO_4 and Mn_2SiO_4 . . . 135
Grout, F. F. Petrography and petrology. [Book review.] . . 494
Grünerite from Lake Superior region. (Richarz) 437
Gruner, J. W., Magnesiosussexite, new mineral isomorphous with sussexite and camsellite 509
——— **New method of building crystal structure models** . . . 35

Hall, G. M., Flattened minerals in muscovite at Spruce

Pine, N. Car. 115
Harwood, H. F. 250
Haüyne and noselite. (Barth) . . 466
Hawkes, L. 250
Hawkins, A. C. and Lewis, J. V., Manual of determinative mineralogy. [Book review.] 123
Hawkins, H. H., Restandardizing of Clerici's solution. . . . 157
Heavy mineral assemblages of plutonic rocks of eastern Oregon. (Reed, Gilluly) . . . 201
Heavy minerals of coastal plain of Maryland. (Dryden) 518
Heavy minerals as a stratigraphic guide. (Edson) . . 116, 429
Hematite. 305
Henderson, E. P. and Ross, C. S., Variations in optical properties and composition in anthophyllite series. 114
Hess, F. L. and Fahey, J. J., Cesium biotite from S. Dak. 173
Hey, M. H. 160, 455
Hodge, E. T., Petrographic succession of tertiary igneous rocks in Oregon. 116
Holden, E. F. and Kraus, E. H., Gems and gem materials. [Book review.] 124
Howard, A. D., Micro-crystals of barite from Calif. 120
Humphreys, W. J. and Bentley, W. A., Snow crystals. [Book review.] 123
Hunt, W. F., Book reviews 123, 200, 494
Idriess, I. L., Prospecting for gold. [Book review.] 573
Irving, J., Vonsen, M. and Gonyer, F. A., Pumpellyite from Calif. 338
Isomorphous substitution of elements in minerals. (Phillips) 85
Ito, T. 39
Jade, identification by means of x-rays. (Merritt) 497
Joaquinite, chemical nature of. (Palache, Foshag) 114, 308
Johannsen, A., Descriptive petrography of the igneous rocks. [Book review.] 41
Juanite, a new mineral. 349, 354
Julienite. (Schoep) 496

Kaolinite from terminal moraine of Staten Island. (Kerr) 29
Karpinski, R. W. Book review. . 573
Kerr, P. F., Kaolinite from terminal moraine of Staten Island. 29
——— Montmorillonite or smectite as constituents of fuller's earth and bentonite. . . 192
——— and Ross, C. S., Manganese minerals near Bald Knob, N. Car. 1
King, B. F., Mineral composition of sands from Monongahela, Allegheny and Ohio rivers. 485
Koechlin, R. 495
Kraus, E. H., Memorial of Friedrich Becke. 226
——— and Holden, E. F., Gems and gem materials. [Book review.] 124

Landes, K. K., Baringer Hill, Texas, pegmatite. 115, 381
Landon, R. E., Desericitization, a process operative during high temperature mineralization. 449
Largest crystal. (Palache) 362
Larsen, E. S., [Book reviews.] . 41, 456
——— and Goranson, E. A., Deuteric and later alterations of the uncompahgrite of Iron Hill, Col. 343
——— and Schaller, W. T., Serendibite from Warren

Co., N. Y. and its paragenesis 457
Lavas of the Modoc Lava-Bed quadrangle, Calif. (Powers) 253
Legrandite, a new zinc arsenate. (Drugman, Hey) 455
Lehrbuch der Erzmikroskopie. (Schneiderhöhn, Ramdohr) [Book review.] 79
Lepidolite system. (Winchell) 551
Leucophosphite. (Simpson) 495
Lewis, J. V. and Hawkins, A. C., Manual of determinative mineralogy. [Book review.] 123
Linear projection in geometrical crystallography. (Rogers) 113

Magnesiosussexite, a new mineral isomorphous with sussexite and camsellite. (Gruner) 509
Manganese minerals of a vein near Bald Knob, N. Car. (Ross, Kerr) 1
Manual of determinative mineralogy. (Lewis-Hawkins) [Book review.] 123
Marcasite and pyrite in nodules, distinction of. (Bannister) 250
Martens, J. H. C., Detrital collophane 153
——— Piperine as an immersion media in sedimentary petrography 198
Mayo, E. B., Two new occurrences of piedmontite in Calif. 117, 238
McLintock, W. F. P. 455
Merritt, P. L., Identification of jade by x-rays 497
Metamorphism produced by combustion of hydrocarbons in Tertiary sediments of S. W. Persia. (McLintock) 455
Meteoric stone from Suwahib, Arabia. (Smith) 39
Meteorite, Beardsley. (Nininger) 563
Meteorite craters at Henbury, central Australia. (Alderman) 39
Meteorites, iron, from Chile and Texas. (Palache, Gonyer) 357
Meteorite, metallic, from Ogallala, Nebraska. (Nininger) 221
Meteorite, Springwater. (Nininger) 396
Miami-Picher zinc-lead district. (Weidman) [Book review.] 573
Microscopic characters of artificial inorganic solid substances or artificial minerals. (Winchell) [Book review.] 404
Mikroskopische Charakertistik der gesteinbildenden Mineralien. (Chudoba) [Book review.] 456
Mineral composition of sands from Monongahela, Allegheny and Ohio rivers. (King) 485
Mineralogical Society of America.
  List of former officers and meetings 118
  Nominations of officers for 1933 454
  Proceedings of 12th annual meeting at Tulsa, Okla. 1932 108
Mineralogical Society of Great Britain and Ireland 39, 159, 250, 455
Mineralogical Society of Southern California 39, 122, 200, 250
Mn_2SiO_4 and Ca_2SiO_4, mix-crystals of (Greer) 135
Monazite colored by carbon, from Nipissing district, Ont. (Ellsworth) 19
Montmorillonite or smectite

as constituents of fuller's earth and bentonite. (Kerr) 192
Mordenite-ptilolite group; clinoptilolite, a new species. (Schaller) ... 128
Morey, G. W. and Tunell, G., Correct and incorrect statements of crystallographic theory in current textbooks ... 365
——— Book review ... 404
Mosesite, new occurrence and x-ray study of. (Bird) ... 541
Mourant, A. E. ... 250
Multiple twins of diamond and sphalerite. (Palache) ... 360
Murray, D. C. ... 39

Natrolite and metanatrolite. (Hey) ... 160
Negative crystal cavities of galena and their brine content. (Buerger) ... 228
New mineral names ... 251, 495
New York Mineralogical Club .. 407
Nininger, H. H., Beardsley meteorite ... 563
——— **Metallic meteorite from Ogallala, Nebr.** ... 221
——— **Springwater meteorite** .. 396
Noselite and haüyne, chemical composition of. (Barth) ... 466

Oxyhornblende. (Winchell) .. 114, 472

Pabst, A., Charles-Francois du Fay, pioneer in crystal optics ... 569
——— Book review ... 539
Palache, C., Biographical notice of W. S. Andrews ... 78
——— **Multiple twins of diamond and sphalerite** ... 360
——— **The largest crystal** ... 362
——— **Zunyite from Guatemala** ... 117, 304
——— **and Foshag, W. F., Chemical nature of joaquinite** ... 114, 308
——— **and Gonyer, F. A., Babingtonite** ... 114, 295
——— **New iron meteorites from Chile and Texas** ... 357
Pallasite, new, from central Australia ... 159
Parry, J. ... 455
Peacock, M. A., Calaverite and the law of complication ... 317
Perthites. (Alling) ... 43
Petrographic succession of Tertiary igneous rocks in Oregon. (Hodge) ... 116
Petrography and petrology. (Grout) [Book review.] ... 494
Philadelphia Mineralogical Society ... 38, 121, 122, ... 200, 249, 408, 538, 539
Phillips, A. H., Isomorphous substitution of elements in minerals ... 85
Phillips, F. C. ... 39
Pickeringite, occurrence in Alberta. (Rutherford) ... 401
Piedmontite, new occurrences in California. (Mayo) ... 117, 238
Piperine as immersion media in sedimentary petrography. (Martens) ... 198
Platinum concentrates from Transvaal. (Bannister) ... 455
Poitevin, E., Preliminary note on ashtonite ... 120
Powers, H. A., Lavas of Modoc Lava-bed quadrangle, Calif. 253
Prospecting for gold. (Idriess) [Book review.] ... 573
Psilomelane and wad, x-ray study of. (Ramsdell) ... 143
Ptilolite from Utah. (Schaller) .. 125
Pumpellyite from California. (Irving, Vonsen, Gonyer) .. 338
Pyrite and marcasite, distinction in nodular growths. (Bannister) ... 250
Pyrrhotite inclusions in sphalerite. (Shenon) ... 514

Quartz-diopside-garnet veinlets. (Goodspeed, Coombs) 554

Ramdohr, P. and Schneiderhöhn H., Erzmikroskopischen Bestimmungstafeln. [Book review] 83
——— Lehrbuch der Erzmikroskopie. [Book review.]... 79
Ramsdell, L. S., X-ray study of psilomelane and wad...... 143
Reed, J. C. and Gilluly, J., Heavy minerals of plutonic rocks of eastern Oregon... 201
Rhodonite, optical and chemical data................. 13
Richarz, S., Grünerite from Lake Superior region...... 437
Rogers, A. F., Euhedral gold crystals from California... 115
——— Linear projection in geometrical crystallography... 113
——— **Sanbornite, a new barium silicate mineral from Mariposa Co., Calif.**. 117, 161
Rosenkrans, R. R., Occurrence of native sulfur in Center Co., Penna........ 248
Rosickyite. (Sekanina)........ 251
Ross, C. S. and Henderson, E. P., Variations in optical properties and composition in anthophyllite series..... 114
——— **and Kerr, P. F., Manganese minerals of a vein near Bald Knob, N. Car.**... 1
Rutherford, R. L., Occurrence of Pickeringite in Alberta.. 401

Sanbornite, a new barium silicate from Mariposa Co., Calif. (Rogers).........117, 161
Schadler, J................. 251
Schairer, J. F., Minerals of Connecticut. [Book review.]... 200
Schaller, W. T., Chemical composition of cuprotungstite.. 234
——— **Memorial of A. S. Eakle**.................. 94
——— **Mordenite-ptilolite group; clinoptilolite, a new species**.................... 128
——— **Ptilolite from Utah**..... 125
——— **Refractive indices of bloedite**................. 530
——— Book review........... 123
——— **and Fairchild, J. G., Bavenite, a beryllium mineral, pseudomorphous after beryl**................114, 409
——— **and Larsen, W. T., Serendibite from Warren Co., N. Y., and its paragenesis**.. 457
Schneiderhöhn, H. and Ramdohr, P., Erzmikroskopischen Bestimmungstafeln. [Book review.]........... 83
———Lehrbuch der Erzmikroskopie. [Book review.]...... 79
Schoep, A.................... 496
Schwartz, G. M., Synthetic minerals for polished surface study................... 478
Scorodite from Japan. (Ito, Shiga).................. 39
Sekanina, J.................. 251
Serendibite, Warren Co., N. Y., and its paragenesis. (Larsen, Schaller)........... 457
Shand, S. J. The study of rocks. [Book review.]........... 40
Shenon, P. J., Chalcopyrite and pyrite inclusions in sphalerite..................... 514
Shift of plane of projection in gnomonic projection. (Wright)................ 423
Shiga, T..................... 39
Short, M. W. Book reviews.....79, 83
Siderolite from west Australia. (Simpson, Murray)....... 39
Simple determinative mineralogy. (Beringer) [Book review.].................. 494
Simpson, E. S...............39, 495

Smectite-montmorillonite. (Kerr) 192

Smith, W. Campbell.......... 39

Snow crystals. (Bentley, Humphreys) [Book review.].... 123

Spencer, L. J................ 159

Spessartite, optical and chemical data................. 16

Sphalerite twins, multiple. (Palache)............... 360

Spherulitic rhyolites of Jersey. (Mourant).............. 250

Spinel, analysis............ 464

Spodumene-bearing pegmatite from Black Hills, S. Dak. (Van Horn)............. 115

Springwater meteorite. (Nininger)................. 396

Stevens, E. H. and Svatik, J., Artificial thermonatrite... 538

Stow, M. H., Authigenic tourmaline in Oriskany sandstone.................. 150

Study of rocks. (Shand) [Book review.]................ 40

Sulphur, native, in Center Co., Penna. (Rosenkrans)..... 248

Sussexite 509

Svatik, J. and Stevens, E. H., Artificial thermonatrite.... 538

Synthetic minerals for polished surface study. (Schwartz). 478

Tarr, W. A., Barite vein cutting granite in S. E. Missouri... ....115, 443

Tellurium, native from Silver City, N. Mex. (Ballmer).. 491

Tephroite, optical data and analysis................. 5

Textbook of mineralogy. (Dana-Ford) [Book review.]...... 539

Thallous formate, preparation of. (Vhay, Williamson).... 560

Thermonatrite, artificial. (Svatik, Stevens)........... 538

Tickell, F. G., Examination of fragmental rocks. [Book review.].................. 40

Tourmaline. (Winchell).....114, 472

Tourmaline, authigenic, in Oriskany sandstone. (Stow) 150

Tunell, G. and Morey, G. W., Correct and incorrect statements of crystallographic theory in current textbooks.................. 365

——— Book review........... 404

Uncompahgrite of Iron Hill, Colorado, deuteric and later alterations of. (Larsen, Goranson)..... 343

Van Horn, F. R., Spodumene-bearing pegmatite from Black Hills, S. Dak........ 115

——— Book review........... 40

Vhay, J. S. and Williamson, A. T., Preparation of thallous formate................. 560

Vonsen, M., Irving, J. and Gonyer, F. A., Pumpellyite from California........... 338

Wad and psilomelane, x-ray study of. (Ramsdell)...... 143

Walcott, A. J. Book review..... 124

Walker, F.................. 250

Weidman, S. Miami-Picher zinc-lead district. [Book review.].................. 573

West, C. D., Structure of dehydrated brucite............ 316

Westman, J.................. 495

Williams, A. F................ 455

Williamson, A. T. and Vhay, J. S., Preparation of thallous formate............. 560

Winchell, A. N., Ferrotremolite, oxyhornblende and tourmaline................114, 472

——— **The lepidolite system**... 551

——— Microscopic characters of artificial inorganic solid substances or artificial minerals. [Book review.]...... 404

——— Book review........... 456

Wischnewite. (Beljankin)...... 252
Wright, F. E., Shift of plane of projection in gnomonic projection.................. 423
——— 455

X-ray examination of chrome ores. (Clark, Ally)........ 66
X-ray identification of jade. (Merritt)................ 497
X-ray study of mosesite. (Bird) 541
X-ray study of psilomelane and wad. (Ramsdell)......... 143

Zunyite from Quatemala. (Palache)................117, 304